1901MNRAS..61..293.

ADDRESS

Delivered by the President, Mr. E. B. Knobel, on presenting the Gold Medal of the Society to Professor E. C. Pickering.

The Council have awarded the gold medal to Professor Edward Charles Pickering "for his researches on Variable Stars and his work in Astronomical Photography," and it is now the recognised duty of your President to submit to you some of the considerations which have actuated them in selecting the distinguished Director of Harvard College Observatory as the recipient of their highest honour.

In attempting to lay before you an outline of the work of our Medallist in the above directions, I am very conscious of the great difficulties attendant upon an adequate presentation of the claims of an astronomer who, combining enthusiasm with devotion, and fertility in resource with surpassing skill, possesses in an eminent degree a comprehensive intellect to disentangle and elucidate, coupled with a power of organisation to carry his enterprise to a successful issue.

It may be truly said that the successful practical astronomer of the present day must possess much greater versatility in his qualifications, and more varied knowledge of the kindred sciences, than would a generation back have been deemed adequate for profound research. The striking advance witnessed during the latter part of the nineteenth century in novel devices in the construction of astronomical instruments, the enormous power for advancing knowledge which has accrued from the development of spectroscopy and photography, have all brought additional claims upon the energy and intelligence of the modern astronomer, which, to ensure success, have to be satisfied and fulfilled.

The study of the extensive researches and varied observations of our Medallist reveals the lucid and vigorous mind that has been applied to the solution of so many difficult problems, and demonstrates the skill and energy which have enabled him to obtain a complete mastery over the processes necessary for the accomplishment of his designs.

The long series of volumes of the *Annals of Harvard College Observatory* published in the past twenty-five years record a wealth of original research far beyond the limits of an address to

1901MNRAS..61..293.

epitomise. On a former occasion the occupant of this chair addressed you on the splendid work accomplished by Professor Pickering in stellar photometry, and I shall hope later on to make some reference to his more recent researches in this direction. There is obviously no finality in astronomical observation, and Harvard teaches us that whether it be a photometric or a photographic survey of the heavens, the work is repeated and revised again and again to correct errors and to record changes and variability which might otherwise escape notice.

Professor Pickering's researches on variable stars date from the commencement of his directorship of Harvard Observatory in 1876. In his first annual report he announces his intention to undertake the extensive work of reducing Argelander's comparative observations of variable stars, by measuring the brightness of the comparison stars, and thus to determine the true brightness of the variables as given in the immense mass of Bonn observations—a work which he published some years later.

His first paper on the subject was published in 1880, wherein from careful mathematical reasoning he proves that the variability of stars of the *Algol* type is due to a non-luminous body revolving round the star; and the results he obtained for the ratio of the diameters of *Algol* and its satellite are very closely accordant with those announced by Vogel nine or ten years later from the Potsdam spectroscopic observations.

A further memoir, which appeared the following year, is extremely suggestive. In considering those variable stars whose light is continually varying, but whose changes are repeated with great regularity in a period not exceeding a few days, his reasoning is of this form :—

Admitting a common origin of the stars of the *Milky Way*, a general coincidence in their axes of rotation is not improbable, especially as such an approximate coincidence occurs in the members of the solar system. If the coincidence were exact, the direction must be that of the poles of the Sun, or approximately that of the pole of the ecliptic. On the other hand, since the stars of the *Milky Way* are supposed to be arranged in the general form of a flattened disc, we should more naturally expect that the axes of rotation would be symmetrically situated with regard to it, or would coincide with its shortest dimension. According to this theory, the axes of rotation would be directed towards the poles of the *Milky Way*.

If we suppose that a great number of variable stars were distributed over the heavens, it is evident that those seen in the direction of their axes would not appear to vary, since, as they turned they would always present the same portions of their surfaces to the observer. Those at right angles to this direction would show the greatest variation, and would appear to be more numerous, since they would be more likely to be detected. If, then, the axes are coincident, we should expect that most of these variable stars would lie along the arc of a great circle, whose

1901MNRAS..61..293.

pole would coincide with their axes of rotation. As a fact, eighteen such variable stars are found to be in a great circle very nearly coincident with the *Milky Way*. And upon this result Professor Pickering sagaciously indicates a method of discovering variable stars of this class by observation of certain parts of the sky.

Numerous early papers on variable stars must necessarily be passed over on the present occasion, but in this domain of observational astronomy it may be interesting to give an example of the indefatigable assiduity of our medallist.

In a photometric study of β *Persei*, he records having made on thirteen nights 2748 comparisons with the neighbouring star ω *Persei*, of which six hundred were made in a single night. On that occasion the observations were continued almost without intermission for $8\frac{3}{4}$ hours. Again, in a similar study of Ceraski's Variable (D. M. 81°—25), he made 3276 comparisons on five evenings, of which nine hundred were obtained on a single night, the probable error of a single minimum determined in this way being only 1·3 minutes.

It was, of course, the development of the photometers he had devised and perfected with so much skill that permitted the acquirement of such a mass of observations, and from the above quotation it would seem that quick-firing weapons are as necessary for attacking celestial problems as for some others of a less peaceful nature.

The study of variable stars is obviously a photometric research, and allusion should therefore be made to some of the more recent processes employed by Professor Pickering in his work. Herein it is noteworthy to mention his ingenious adaptation of Professor Pritchard's Wedge Photometer, to be used as a transit photometer for determining the magnitudes of stars too faint to be measured by the Meridian Photometer. This instrument consisted of an ordinary wedge of tinted glass cemented to a glass plate carrying an opaque bar parallel to the thinner end of the tinted wedge. The plate is placed in the focal plane of the telescope, and the bar is made coincident with an hour circle. The interval between the transit of a star across the bar and its disappearance in the wedge is the observed quantity from which the brightness of the star is deduced. The thirteenth volume of the *Harvard Annals* contains a catalogue of 4143 stars from the 8th to the 14th magnitude, whose brightness was determined by this most ingenious arrangement.

It was at Harvard College Observatory that the birth of stellar photography took place in the year 1850, when Bond and Whipple succeeded in obtaining satisfactory images of bright stars on a daguerreotype plate. It was natural, therefore, that Professor Pickering should early avail himself of the immense aid to astronomy afforded by the invention of the photographic dry plate to assist his researches on variable stars and stellar photometry.

1901MNRAS..61..293.

In a highly interesting memoir on stellar photography published in 1886, he pointed out that the different photometric processes which hitherto had been used in determining the light of the stars, give results which differ systematically when large variations in light are to be measured. This is not due to a difference in the assumed value of the unit of the scale of magnitudes, but to an actual difference in the measurement of the amount of light. He suggests that photography affords an excellent means of determining systematic differences in photometric catalogues, as the errors in that case will be of a very different kind. To carry this into effect, he points out the advantages that will accrue from photographing stars without moving the telescope. Thus each star by the diurnal motion will form a trail upon the plate. Such trails will appear as lines whose intensity is perfectly uniform within the limits of accuracy of which the comparison is capable; and he found that small differences in light are much more perceptible in the trails than in the circular images obtained when the telescope is driven by clockwork. In his hands this original method assumes a considerable scientific value. For the brighter stars, even when near the Equator, a trail is formed when the camera is stationary; for others less bright the duration of the transit can be regulated as need requires. It is obvious that as the stars approach the pole the trails made during a given exposure become shorter, and the photographic action is lengthened, so that when the camera is pointed to the pole trails of stars as low as the 14th magnitude can be easily photographed.

The method of trails was applied not only to the photometry of stars, but also in a most interesting and instructive way in photographing stellar spectra, referred to later on.

The mode of determining the magnitudes from trails was to compare the trail of a star whose brightness had been obtained in various ways, with the trails of those stars whose magnitude was sought. Obviously there must be systematic differences in the magnitudes of stars determined by visual and by photographic methods, and the comparisons instituted clearly indicated such differences. The evidence showed that for stars brighter than the fifth magnitude the numerical photographic magnitudes are in excess of the photometric magnitudes by one unit, and in faint magnitudes the reverse condition holds, as is possible from other considerations which cannot well be dwelt upon here. In an exhaustive discussion, Professor Pickering indicates the many advantages presented by this interesting method for determining not only the brightness but also the position of stars.

In endeavouring to give you some idea of the skill, vigour, and enterprise which characterise our Medallist, I would now pass to that magnificent work which has been organised and carried into such successful execution by him, under the title of the Henry Draper Memorial—a work which has given some of the most brilliant results for our admiration.

1901MNRAS..61..293.

The numerous researches undertaken at Harvard College Observatory have needed not only a corps of highly skilled observers, but also an array of instruments of various kinds and various calibres; all for their efficient use requiring considerable funds. To the great honour of Professor Pickering's countrymen and countrywomen, the value of his researches has been perceived and justly appreciated, and by means of much generous pecuniary assistance he has been enabled to accomplish schemes which he rightly considered would advance our science.

But this, we are happy to recognise, is not singular in a land where there is such keen appreciation of all enlightened and intellectual methods, where there is continual striving towards high ideals in philosophy and science, and where there are so many generous benefactors ready to give princely sums to found colleges, to establish observatories, and to encourage in every way the pursuit and advancement of knowledge.

The work alluded to above has been effected by the liberal provision made by Mrs. Draper in 1886 for carrying on researches in Stellar Spectroscopy, as a memorial to her late husband, Professor Henry Draper, who was so successful a worker in the new lines of research which the development of the spectroscope and of photography had opened out.

Her beautiful idea was framed to embrace a complete discussion of the constitution, the conditions and the physical properties of the stars as revealed by their spectra. It is difficult to conceive a more appropriate way of hallowing the memory of a distinguished man, than by efforts to enlarge and enrich the science in which he laboured and to which he was so devoted. Accordingly, in placing that trust in Professor Pickering's hands, he was supplied with instruments suitable for the undertaking, and with funds sufficient to enable him to carry the work into execution.

The results hitherto published are contained in three volumes of the *Harvard Annals*, besides numerous circulars and shorter papers describing specific discoveries. The investigations were planned to cover the entire sky, and when, in the course of a few years the scheme was fully developed, four telescopes were established for the observations—two at Cambridge for the northern hemisphere, and two at Arequipa, in Peru, at an altitude of 8000 feet, for all stars too far south to be observed at the former observatory. The principal instrument at each station was an 8-inch photographic doublet of large angular aperture and short focal length, permitting photographs to be obtained extending over a region 10° square. In addition to these, an 11-inch refractor was employed at Cambridge and a 13-inch at Arequipa. The dispersion in all cases was obtained by one or more prisms over the object-glass, which could be conveniently removed to allow of the instrument being used for ordinary stellar photography.

The magnificent volume which embodies the principal results

1901MNRAS..61..293.

has been appropriately entitled *The Draper Catalogue.* When we learn that herein are contained the details of the spectra of 10,351 stars, deduced from the measurements of 28,266 spectra, we can form some idea of the magnitude of Professor Pickering's operations, and appreciate his inspiriting influence on all those who so ably assisted him in completing this portion of the work. Particularly is it interesting to see the important part of the work undertaken by lady assistants, one of whom—Mrs. Fleming—is entitled to our gratitude, as from her minute and accurate examination of the photographs she has been able to announce some of the most interesting discoveries in variable stars and stars with peculiar spectra that have been recorded.

In photographing the spectra, the prism with a reflecting angle of 13° was adjusted so that its refracting edge was placed perpendicular to the axis of the earth. The spectrum of the star formed a line on the plate; then, by altering the rate of the driving clock this line was allowed to trail slowly over the plate to give an image of a desired width. By this elegant means spectra were obtained of all stars down to the seventh magnitude, of such dimensions that they could be studied and classified. Hitherto the method of using a narrow slit, supplemented or not by a cylindrical lens, and requiring extreme accuracy in the driving clock, and even then a continued personal vigilance for the manual correction of its irregularities, has proved a most serious drawback in the register of stellar spectra by the aid of photography. By the method of trails, the slit, the cylindrical lens, and the painful watching are dispensed with, and, as has been well remarked, "the light of the star itself, by diurnal motion, becomes virtually a line of light or illuminated slit, which is dispersed into its spectrum by the refracting prism." We may well admire the beauty and simplicity of this method, so essentially practical, and so capable of yielding a mass of results available for leisurely study. It undoubtedly marks a distinct advance in photographic astronomy.

The spectra in *The Draper Catalogue* are classified in an original and somewhat minute manner. Secchi's type I., the Sirian stars, are subdivided into four varieties. The solar stars, type II., into eight varieties. The third type is not subdivided, and it would seem that the difference between this and the second type is much less marked in the photographic than in the visible portion of the spectra. The fourth type of red stars are absent. A separate classification is given to stars with bright lines, and planetary nebulæ, which Professor Pickering considers as together forming a fifth type.

One remarkable result appears from the study of this valuable catalogue. Practically two-thirds of Milky Way stars are found to be Sirian stars, belonging to type I., thus confirming to a certain extent Kapteyn's discovery that "stars of the Milky Way are in general bluer than the stars in other regions of the sky;" in other words, that they are photographically more brilliant.

1901MNRAS..61..293.

In Professor Pickering's careful discussion of every feature of *The Draper Catalogue* one is rather bewildered by the multitude of original and far-seeing thoughts deduced from the study of the spectra of the whole heavens. One striking conclusion may be here mentioned : that, with few exceptions, all the stars may be arranged in a sequence, beginning with the planetary nebulæ, passing through the bright-line stars to the *Orion* stars, thence to the first type, and by insensible changes to the second and third type stars ; and he adds, "the evidence that the same plan governs the construction of all parts of the visible universe is thus conclusive."

But what has already been published in *The Draper Catalogue* does not represent one-half of what has been accomplished ; for we learn that there exists, as yet unpublished, a second *Draper Catalogue*, giving the spectra of 30,000 stars down to the eighth magnitude, from the north to the south pole, a mass of material from which we may anticipate many valuable lessons and unexpected discoveries.

One of the principal objects of the Henry Draper Memorial was to investigate the physical constitution of the stars, and in the first instance their relative magnitudes. For this purpose photographs of three kinds were obtained—viz. trails, circular images, and spectra. The first of these has already been alluded to. In the second method, when the telescope was driven by clockwork to give circular images, the scale for determining magnitudes was obtained by taking a series of exposures on a given cluster of stars, moving the telescope slightly in right ascension after each one. Professor Pickering had found that Pogson's ratio of 2·5 for a difference of one magnitude was too low for photographic magnitudes, and that three times the exposure would bring the results more in accord with visual magnitudes. Accordingly, each exposure in the above series was one-third less than that preceding, and thus the scale for comparison was formed.

With regard to the determination of relative magnitudes from the spectra, the very original and interesting plan was adopted of comparing the density of the photographed spectra in the vicinity of the G line with a prepared scale of densities. The measurement of relative brightness between two stars differing materially in colour is very imperfectly obtained by visual methods. Indeed, Wilhelm Struve doubted whether it would ever be possible for photometry to decide which was the brighter of two stars differing in colour, such as *Arcturus* and *Vega*. The ingenious method of Professor Pickering, though it is limited to measuring the brightness of stellar light of a particular refrangibility, is nevertheless a most important step in a new direction for comparing magnitudes, and opens out some interesting ideas for our consideration. In addition to what we have already in our hands, Professor Pickering has prepared the material for an investigation of the photographic brightness of 40,000 standard

1901MNRAS..61..293.

stars of about the tenth magnitude, which we hope may shortly be given to the world.

The discussion and comparison he subsequently undertakes, of different methods of ascertaining the brightness of stars, shows naturally very conflicting results ; and he concludes that the determination of the true relative brightness of the stars, either visually or photographically, is a much more difficult problem than would appear at first sight. It must be left to future investigators to decide which of the various processes employed gives the correct result. The spectra in *The Draper Catalogue* were all photographed with the 8-inch telescopes and were on a small scale. For bright stars the 11-inch telescope was used, giving spectra on a much larger scale—the results of which are published in a separate volume, and discussed by Professor Pickering with his usual acumen. At Arequipa similar work was undertaken with the 13-inch telescope.

The 8-inch telescopes were also employed in star charting. With these instruments photographic charts of the entire sky from the north to the south pole have been obtained every year, showing all stars brighter than the thirteenth magnitude.

The photographs obtained up to the present time by the four telescopes employed in the Henry Draper Memorial amount to the astounding figures of 52,229 plates taken with the two 8-inch telescopes, 12,872 with the 11-inch, and 10,214 with the 13-inch. When we bear in mind that these figures signify repeated surveys of the whole heavens—spectrographic, photometric, and photographic—extending continuously over several years, we cannot fail to realise the enormous treasure thus stored up for us by the Harvard Observatory.

The resources at Professor Pickering's disposal were very materially increased in the year 1889 by the generous gift of a large sum of money from Miss Bruce, of New York, for a 24-inch photographic telescope, "to be used under favourable climatic conditions in such a way as in the judgment of Professor Pickering would best advance astronomical science."

The establishment of a branch of Harvard College Observatory in the southern hemisphere, at the high altitude of Arequipa, in Peru, is a conspicuous instance of the Director's foresight of the necessities of modern astronomy to reduce the climatic difficulties of low-lying stations ; and it was also a magnificent and unique idea to bring the whole stellar universe thus within his grasp. Accordingly, when the Bruce telescope was constructed, it was mounted at Arequipa, where it has been in regular use on special lines of research. Up to last year nearly 5000 photographs had been taken with it of planets, asteroids, nebulæ, and particular star fields.

One triumph of this telescope has already been announced by Professor William Pickering in the apparent discovery of a new satellite to the planet *Saturn*. This object is extremely small and faint, and we await at the moment confirmatory observations.

1901MNRAS..61..293.

Among so many noteworthy features of our Medallist's work, there is, perhaps, no one more remarkable than the exceedingly ingenious instrument he invented for automatically charting the heavens. This instrument automatically photographs all stars down to the sixth magnitude as they transit during the night. It consists of a doublet of 6 inches aperture and about 2 feet focal length, mounted so as to make a complete circle of the meridian every twenty-one minutes. A clock automatically starts the movement, and the camera revolves in steps of 2° every two seconds until it has completely covered the meridian, an operation which takes six minutes. After an interval of a quarter of an hour the operation is repeated. At the end of three hours, during the half revolution, when the instrument is pointing to the Earth, the plate is shifted automatically, and the instrument got ready for the next exposure. The two seconds exposure is enough to photograph all stars down to the sixth magnitude, and all these are registered on the plate. Any new star or remarkable variable rising above the sixth magnitude, or any comet of equal brightness, would be recorded on these plates. Truly the ingenuity of such an arrangement must claim our interest and admiration.

To turn now to the discoveries that have resulted from these various researches, we do not find that that admiration is in any way limited.

The classification of stars according to their spectra is so far-reaching that Professor Pickering thinks it should be applied to each of their other properties. Of the variable stars, it appears, as we have said, that all known *Algol* stars have spectra of the first type, while long-period variables in general are of the third type, and have the hydrogen lines bright when near their maxima. This property has led to the discovery of numerous objects of this class, and no exception has been found of a star having this spectrum whose light does not really vary. Up to 1893 twenty new variable stars had been so discovered. Again, in variables of long period discovered visually, over forty have the hydrogen lines bright. Of such long-period variables, however, his photographic discoveries transcend those made visually. Some 150 of these variables have been discovered from the photographic plates, and the measurements and reductions of at least one-third have already been completed from about 100 plates of each star.

The Harvard circulars from 1895 to the present time contain numerous announcements of discoveries of variable stars from the examination of their spectra. The accounts are surprising indeed. Peculiarities in the spectrum of a particular star attract the attention of that most careful observer, Mrs. Fleming. Eighty-seven photographs of that region during the previous nine years are examined without trace of the star; then it appears in eight more recent photographs, and the existence of a new star is established. Or, if we take the case of a new *Algol* variable being discovered elsewhere, Professor Pickering immediately finds that

1901MNRAS..61..293.

that region had been covered by 195 plates, all showing the spectrum of the star in varying degrees of brightness, and enabling the period of variability to be determined with a probable error of only one or two seconds. The minor planet *Eros* was discovered by Witt on 1898 August 13, but the examination of the Harvard photographs enabled Professor Pickering to announce that it could be detected on fifteen or sixteen plates taken from 1893 to 1896, and that the spectrum photographed in January 1894 was, like that of other planets and the Sun, of the second type. A remarkable photograph taken in February 1894 shows the planet as a long trail, while the images of stars are round. An ingenious method of photographing this planet when it was too faint to be observed in other ways was adopted last year. An eyepiece was connected with the photographic plate by means of a micrometer screw. A star was followed by means of the eyepiece, while a motion equal to that of *Eros* was given to the plate. On the plates the stars formed trails, while *Eros* appeared as a circular image.

Fourteen new stars have been discovered since 1572, when Tycho discovered the celebrated one in *Cassiopea*. Four of these were discovered by the Harvard photographs, viz. *Nova Normæ*, *Nova Carinæ*, *Nova Centauri*, and *Nova Sagittarii*, and in proof of this Professor Pickering has submitted copies of his photographs of the regions at different dates, showing in each case on the latter date a bright star which was non-existent at the earlier. With regard to the new star discovered by Anderson in February 1892 in the constellation *Auriga*, commonly called *Nova Aurigæ*, the earliest records are found upon the Harvard plates.

Eighteen photographs of the region taken with one of the 8-inch telescopes from November 1885 to November 1891 showed no trace of the star, though stars of the thirteenth magnitude were visible; but on plates exposed December 16 1891 to January 31 1892 the *Nova* is clearly shown as a fifth magnitude star. With the automatic instrument described above, plates were exposed on the region from October 21 to December 1, 1891, without indicating the *Nova*, but those exposed by the same instrument December 10 1891 to January 20, 1892, exhibit the new star quite clearly. That is to say, it was distinctly photographed by Professor Pickering six or seven weeks before its discovery by the Edinburgh astronomer.

Again, eight photographs taken in 1887 show a star in *Perseus* with bright hydrogen lines. No trace of such star is found in eighty-one photographs taken in the subsequent eight years. It is therefore proved that a new star blazed out in *Perseus* in the year 1887, which would have eluded observation altogether but for these priceless Harvard records.

Perhaps there is no more surprising discovery due to the organisation of the Henry Draper Memorial than that announced by Professor Bailey, the astronomer in charge of the Arequipa Observatory, that numerous globular clusters contain an extra-

1901MNRAS..61..293.

ordinary number of variable stars. In the dense cluster ω *Centauri* there are 128 variable stars; in Messier 3, 132; in Messier 5, 85; and in Messier 15, 51. And as proof of the exhaustless manner in which such remarkable discoveries are investigated, we learn that Professor Pickering is already preparing for the press a series of 30,000 observations of the variable stars in the cluster ω *Centauri* alone.

The Arequipa photographs, from the careful examination of Mrs. Fleming, reveal that there are numerous stars which have peculiar spectra unlike any other stars. The spectra contain lines which are apparently due to some elements quite unknown in other stars, or on the Earth, and we have here a new field opened out for research.

These interesting discoveries afford food for prolonged study and consideration, but one result of the boundless energy of Professor Pickering is to forestall future discovery. No one will be able to claim the discovery of a new variable, or a new star, until he has satisfied himself that Harvard has not anticipated him by its numberless photographic records. All the more honour, however, to that observatory that it should have laid up stores of such valuable photographs, the examination of which cannot but increase our knowledge of the nature and distribution of the stars, and expand our ideas of the construction of the heavens.

The consideration of Professor Pickering's work in astronomical photography would not be complete without some, though on this occasion very brief, mention of his interesting photographic determination of the laws of atmospheric absorption—a question of capital importance in the photometric researches already alluded to. By photographing the trails of stars at upper and lower culmination on the same plate, with a certain system of exposures, data were obtained capable of yielding a value for the coefficient of absorption in fair agreement with determinations previously made with the Meridian Photometer.

It remains for me to say one word respecting our Medallist's recent work with the Meridian Photometer. Not only has the work known as the *Harvard Photometry* been completely revised and the magnitudes re-measured, but the same instrument as used in some of the earlier observations, was sent to Peru, and in the capable hands of Professor Bailey it was used to determine the photometric magnitudes of the whole of the southern hemisphere in the same way as it had been employed for the northern.

Thus, Professor Pickering has completed a photometric survey on a uniform plan of the whole heavens, involving a million observations; and, as we already know, he has also accomplished a photographic determination of brightness with uniform instruments for both hemispheres.

I venture to sum up his work in the following citation, which

1901MNRAS..61..293.

expresses in far better words than I can employ the abstract of his labours :—

"Harvard College Observatory is a wonderful focus of activity, in which one hardly knows whether he ought most to admire the exhaustless energy or the admirable ingenuity which he finds displayed in it. Its work has been aided by gifts which have no parallel in the liberality that prompted them. Yet without energy and skill such gifts would have been useless. The activity of the establishment includes both hemispheres. Time would fail to tell how it has not only mapped out important regions of the heavens from the north to the south pole, but analysed the rays of light which come from hundreds of thousands of stars by recording their spectra in permanence on photographic plates. The work of the establishment is so organised that a new star cannot appear in any part of the heavens, nor a known star undergo any noteworthy change, without immediate detection by the photographic eye of one or more telescopes—all-seeing and never-sleeping policemen—that scan the heavens unceasingly while the astronomer may sleep, and report in the morning every case of irregularity in the proceedings of the heavenly bodies."

Time, however, will not permit me to offer all the evidence that might be adduced in support of the plea I have been urging. The task of doing full justice to a multitude of researches, so varied and original, and so replete with interest, is a very difficult one; but notwithstanding this inadequate and imperfect presentment of the labours of our illustrious Associate, I trust I have at least succeeded in satisfying you that he has fully merited the recognition the Council have accorded him.

The history of the award of the Gold Medal is the history of men who have made an indelible mark in astronomy—whose labours have stimulated and pioneered others in the path of success, and whose disciples have expanded and developed the principles which they enunciated, to the realisation of such progress in astronomical science as we are witnessing at the commencement of the twentieth century. Among such a roll of distinguished men, Professor Pickering will surely take an honourable place, as a brilliant leader, who, with rare skill, unwearied energy, and consummate ability, has known so well how to instigate, how to organise, and how to accomplish.

The President, addressing the American Ambassador, said :

Mr. Choate, I beg to thank your Excellency for the honour you have done the Royal Astronomical Society this day in so kindly appearing here to represent the distinguished Director of Harvard College Observatory.

In handing you this medal for conveyance to Professor Edward Charles Pickering, I beg you to assure him of our high

1901MNRAS..61..293.

appreciation of his remarkable labours in stellar astronomy, and our continued interest in the important institution he so ably directs. We do not suppose that one who has displayed an unwearied activity throughout his whole career can need any such stimulus to nerve him to increased efforts for the advancement of our science; we only trust he will believe that, in offering him the highest honour in our power, we feel that we shall be equally honoured by his acceptance of it.